

WHAT IS CLAIMED IS:

1. A semiconductor device comprising:  
an optical transmission region; and  
a light receiving part for converting light  
5 propagating through the optical transmission region to  
an electrical signal,

wherein the optical transmission region comprises  
a two-dimensional optical waveguide layer, and wherein  
at least a portion of the light receiving part is  
10 embedded in the optical transmission region.

2. The semiconductor device according to claim 1,  
wherein an electric wiring layer is stacked on the  
optical transmission region.

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3. The semiconductor device according to claim 1,  
wherein the light receiving part is embedded in the  
optical transmission region such that the light  
receiving part can directly receive light propagating  
20 through the two-dimensional optical waveguide layer.

4. The semiconductor device according to claim 1,  
wherein the light receiving part is embedded such that  
the light receiving part can receive light propagating  
25 within a plane of the two-dimensional optical waveguide  
layer without directivity.

5. The semiconductor device according to claim 1, wherein the at least a portion of the light receiving part embedded in the optical transmission region has a spherical surface.

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6. The semiconductor device according to claim 1, wherein the light receiving part includes a spherical device.

10 7. The semiconductor device according to claim 1, wherein a portion of a light emitting part for transmitting light to the optical transmission region is embedded in the optical transmission region.

15 8. The semiconductor device according to claim 2, wherein the optical transmission region is interposed between the electric wiring layer located on the optical transmission region and another electric wiring layer located under the optical transmission region,  
20 and wherein at least a portion of the electric wiring layer is electrically connected to at least a portion of the another electric wiring layer by a via hole for penetrating the optical transmission region.

25 9. The semiconductor device according to claim 2, wherein at least one of O/E conversion or E/O conversion between an electronic device provided on the

electric wiring layer and the optical transmission region is performed using a spherical device.

10. An optoelectronic board comprising at least  
5 two layers consisting of a first layer and a second layer, the first layer including the electronic device, the optical device and an electric wiring for coupling the electric and optical devices, and the second layer including a two-dimensional optical waveguide, wherein  
10 the optical device comprises a light receiving part for receiving optical waveguided through the two-dimensional optical waveguide, and wherein at least a portion of the light receiving part is embedded in the two-dimensional optical waveguide.

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11. The optoelectronic board according to claim 10, wherein the two-dimensional optical waveguide has a sheet-shaped form.

20 12. The optoelectronic board according to claim 10, wherein the light receiving part has a spherical structure, the light receiving part is mounted from a surface of the substrate such that the light receiving part is embedded in the optical waveguide, and the  
25 light receiving part is coupled with the electric wiring on the surface of the substrate.

13. The optoelectronic board according to claim 10,  
wherein the optical device is provided with a light  
receiving part and an electric circuit for driving the  
light receiving part or amplifying an electric signal  
5 obtained.

14. The optoelectronic board according to claim 10,  
wherein a light source of the optical device has a  
spherical shape, is mounted on the substrate from a  
10 surface thereof such that the light source embedded in  
the optical waveguide of the substrate, and coupled  
with the electric wiring on the surface of the  
substrate.

15 15. The optoelectronic board according to claim 10,  
the substrate further comprising: a transmission device  
for transmission having a spherical structure; and a  
parallel signal line, wherein an output terminal of the  
parallel signal line is coupled with the transmission  
20 device for transmission, and wherein the transmission  
device for transmission conducts parallel/serial  
conversion and sends a serial optical signal to the  
two-dimensional optical waveguide.

25 16. The optoelectronic board according to claim 15,  
wherein the serial optical signal is received by the  
light receiving part embedded in the two-dimensional

optical waveguide, converted to an electric signal,  
subjected to serial/parallel conversion by an  
electronic circuit simultaneously formed on the light  
receiving part and transmitted to the parallel signal  
5 line.

17. The optoelectronic board according to claim 10,  
wherein the optoelectronic board is made of a flexible  
substrate material.

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18. An optoelectronic integrated circuit  
comprising an electronic device and optical device  
integrated on a surface of a spherical semiconductor  
substrate, wherein the optical device is a light  
15 receiving element includes a multi-layer film  
containing a pn junction, the electronic device  
includes at least a bias circuit for applying a reverse  
bias to the light receiving element, and an amplifier  
for amplifying a signal obtained by converting a  
20 received light to an electric signal.

19. The optoelectronic integrated circuit  
according to claim 18, wherein at least a portion of  
the light receiving element is embedded in an optical  
25 transmission medium.

20. The optoelectronic integrated circuit

according to claim 18, wherein the spherical semiconductor substrate is made of an Si single crystal.

21. The optoelectronic integrated circuit  
5 according to claim 18, wherein the spherical semiconductor substrate is made of a GaAs single crystal.

22. The optoelectronic integrated circuit  
10 according to claim 18, wherein the multi-layer film of the light receiving element is made of p-Si, i-Si and n-Si.

23. The optoelectronic integrated circuit  
15 according to claim 18, wherein the multi-layer film of the light receiving element is made of p-GaAs, GaAsN and n-GaAs.

24. A method of producing the optoelectronic  
20 integrated circuit according to claim 18, which comprises forming the multi-layer film of the light receiving element by ion implantation.

25. An optoelectronic integrated circuit  
25 comprising an electronic device and optical device integrated on a surface of a spherical semiconductor substrate, wherein the optical device is a light

emitting element includes a multi-layer film containing a pn junction in a radial direction of the spherical semiconductor substrate, and the electronic device comprises a bias circuit that applies a forward bias to  
5 said light emitting element.

26. The optoelectronic integrated circuit according to claim 25, wherein at least a portion of the light emitting element is embedded in an optical  
10 transmission medium.

27. An optoelectronic integrated circuit comprising an electronic device and optical device integrated on a surface of a spherical semiconductor  
15 substrate, wherein the optical device is formed by flattening a portion of the surface of the spherical semiconductor substrate and thereby exposing a plurality of small planes, and stacking a multi-layer film containing a pn junction on the small planes, and  
20 the electronic device includes at least a bias circuit for applying a reverse bias or a forward bias thereto.

28. The optoelectronic integrated circuit according to claim 27, wherein the optical device is  
25 embedded in an optical transmission medium.

29. The optoelectronic integrated circuit

according to claim 27, wherein the spherical semiconductor substrate is made of an Si single crystal.

30. The optoelectronic integrated circuit  
5 according to claim 27, wherein the spherical semiconductor substrate is made of a GaAs single crystal.

31. The optoelectronic integrated circuit  
10 according to claim 27, wherein the spherical semiconductor substrate is made of an InP single crystal.

32. The optoelectronic integrated circuit  
15 according to claim 27, wherein the spherical semiconductor substrate is made of a GaN single crystal.

33. The optoelectronic integrated circuit  
according to claim 27, wherein the multi-layer film  
20 containing the pn junction is composed of p-(Al, Ga)(As, P, N), i-(Al, Ga)(As, P, N), n-(Al, Ga)(As, P, N).

34. A method of producing the optoelectronic integrated circuit according to claim 27, comprising  
25 the steps of flattening a portion of a surface of the spherical semiconductor substrate, exposing a plurality of small planes, and stacking a multi-layer film



containing a pn junction on the small planes in the radial direction, a region other than the small planes on the surface of the spherical semiconductor substrate is covered with a dielectric film, and the multi-layer  
5 film containing the pn junction is selectively stacked only on the small planes by organic metal epitaxial growth or gas source molecular beam vapor deposition.

35. A method of producing the optoelectronic  
10 integrated circuit according to claim 34, wherein the small planes obtained by flattening a portion of the surface of the spherical semiconductor comprises crystal planes equivalent to one another in terms of crystal engineering or chemically similar to one  
15 another.